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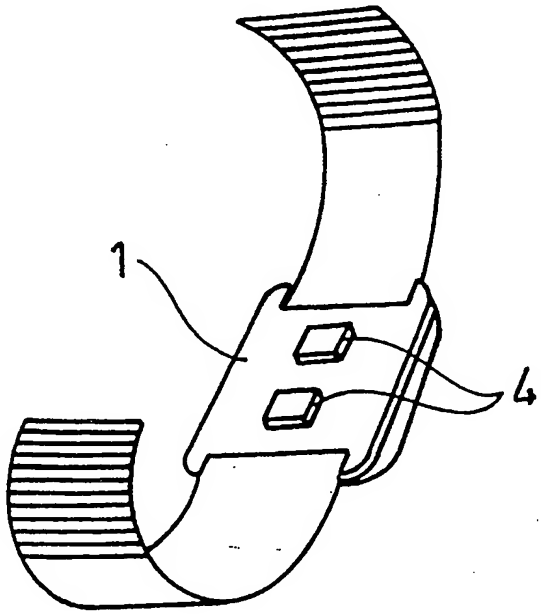
(54) Title: WRIST-HELD MONITORING DEVICE FOR PHYSICAL CONDITION



(57) Abstract

The invention relates to a monitoring device for physical condition, including a wrist-held detector and transmitter unit (1) and at least one separate receiver (2), to which a surveillance message or an alarm is delivered by means of a radio frequency message. The detector means include a sensor (4) for physiological condition and an acceleration sensor (5) which controls a fuzzy logic (7) such that, depending on the movement activity, sliding alarm limits are set for the physical condition sensor (4).

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Wrist-held monitoring device for physical condition

The present invention relates to a wrist-held monitoring device for independently observing the physical condition of a person by means of motoric activity and physiological condition, e.g., temperature and/or electric conductivity of the skin. The anomalous condition data is transmitted by conventional technique on a radio frequency message to one or more receivers, which either set off a local alarm or the data is transferred by conventional technique to a centralized receiving point for alarms.

A wrist-held device for the independent and on-line surveillance of movement and physical condition is not yet in sight. Traditionally, the surveillance has been effected by using extra-personal sensors, e.g. by monitoring the use of a door. The problems include a long monitoring time, high installation costs as well as false alarms as a person under surveillance leaves the space without switching off the surveillance. There are also portable radio transmitters provided with a switch for indicating the posture of a person; a problem with such devices are false alarms as the user must remember to take off the device when lying down. Another problem is that the surveillance is only active when a person is on his or her feet.Prior known is also monitoring of the heart, but that does not provide information about motoric activity and is not suitable for motion control. The heart monitoring devices are also traditionally expensive and require a frequent battery replacement and are not suitable for applications with a lot of users in a restricted area or when a long-time surveillance is required.

An object of the invention is to provide a wrist-watch type of device, which the carrier wears constantly in his or her wrist and which monitors physical condition independently and on-line

as well as issues an alarm upon detecting an abnormal situation. This object is achieved with the invention on the basis of the characterizing features set forth in the appended claim 1. The wrist-held device delivers an alarm, which carries an ID-code specifying the transmitting device, to a separate receiver or a plurality of receivers which can even cover an entire hospital or region. The receivers can be connected to various local alarms or to an emergency phone. The device may offer the user a conventional chance to set off a self-induced alarm with a press button. The physical condition surveillance by means of the motoric activity and physiological condition is, however, the main function of the device. The device is capable of achieving a so-called functional time surveillance for the elderly, i.e. incidents that a person being monitored falls, loses consciousness or ability to move will be identified and the device automatically produces an alarm. The wrist alarm is also suitable for the surveillance of wandering dementia patient as well as for use as assault alarms. All active deductions and the processing of sensor messages take place in the wrist alarm with a simple and very low-current technique, the device being operable for very long periods on the same batteries.

The invention will now be described in more detail with reference made to the accompanying drawings, in which

Fig. 1 shows a device of the invention, including a wrist-held detector and transmitter unit 1 and a separate receiver unit 2.

Fig. 2 is a bottom view of the detector and transmitter unit.

Fig. 3 shows a general block diagram for a device of the invention.

Fig. 4 shows how fuzzy logic is applied to interpret the mutual dependency of the different sensors, and

Fig. 5 shows an example of a logical flow chart for signals and pulses associated with operation of the device.

A device of the invention includes a wrist-watch size detector and transmitter unit 1, whose bottom is fitted with silver-plated contact surfaces for a sensor 4 of temperature and/or electric conductivity of the skin. Alternatively or in addition, the sensor 4 may include a sensor which detects or indicates a heartbeat. Upon monitoring the heart operation, one heartbeat is sufficient during each watching period, whereby no pulse counting is made in order to reduce the current consumption. The device is also provided with an acceleration sensor 5, and a pulse detector 6 for the acceleration sensor, a counter 7A for counting the pulses from detector 6, a fuzzy logic 7 for handling ar analysis the information from sensors 4 and 5, and a radio transmitter 9. The alarm conditions are interpreted on the basis of the sensor signals by means of the fuzzy logic as will be explained later. A separate receiver unit 2 is fitted with an alarm relay release 11 and a radio receiver 10.

The electric skin conductivity and/or temperature of skin is measured with contact surfaces of sensors 4. After A/D transformation, the signal from sensor 4 is measured by counter 7B. By means of fuzzy logic 7, e.g. the electric skin conductivity may be used to control the counting rate of counter 7A in a manner that a high skin resistance decelerates the counter 7A and a low skin resistance accelerates the counter 7A, thereby defining sliding alarm limits. In a typical case (Fig. 4), however, the fuzzy logic 7 controls the mutual depency of the different sensors 4 and 5 such that by means of a signal from acceleration sensor (5) an estimate of movement

activity is made, and this estimate is used to determine the sliding alarm limits (Min and Max) for signals from sensor(s) 4. If the counting value of counter 7B for one or more of the sensors 4 falls outside said sliding alarm limits (Min and Max), then an alarm is caused first in an alarm unit 12 of the wrist held device and, if the alarm is not quitted in a predetermined time by button 13, then the alarm is transmitted to receiver 2/10. If the counting value(s) of counter 7B is (are) within said limits, then the counters 7A, 7B are reset to zero for a new watching period.

Acceleration sensor 5 detects the hand movements and uses pulse detector 6 also to deliver a pulse to the fuzzy logic whenever a sufficiently extensive movement is detected. If it is not reset to zero within a determined period of time, the counter 7A will switch on radio transmitter 9 which sends an alarm to receiver 10. So, in addition to the general movement activity, the acceleration sensor 5 may be used to indicate the rate of acceleration of individual hand movements.

A counter 8 is used to count a predetermined number of pulses delivered by the acceleration sensor 5 so as to switch on radio transmitter 9 and to send a so-called dementia message reporting that a monitored person is moving. If a receiver defining the area to be monitored receives such a message, an alarm will be released. When a user takes off the wrist alarm, the contact surfaces measuring electric conductivity and/or temperature of the skin set the counter rate to such a slow level that an alarm is not released if a user removes the device e.g. when having a shower or sauna. When leaving home, the device is retained in the wrist and, thus, false alarms are not produced as a result of even a long absence.

An example of the logical operation of wrist alarm 1 and detectable factors of the device are illustrated in fig. 5. In

this case, the controlling signal for a wrist alarm is electric conductivity of the skin, which is obtained from contact surfaces 4 controlling the rate of counter 7A, whereby a high electric conductivity of the skin results in the counter reaching an alarm threshold 8 more quickly, the alarm switching on radio transmitter 9. When a user is moving his or her hand, the acceleration sensor 5 delivers a reset pulse to counter 7A and counting is started from the beginning. Counter 8 transmits a dementia message after receiving a sufficient number of pulses.

Claims

1. A monitoring device for physical condition, including a wrist-held detector and transmitter unit (1), fitted with detector means (4, 5) for monitoring physical condition and a radio transmitter (9) for delivering a surveillance or alarm signal, as well as at least one separate receiver (2) for delivering either a local surveillance message or an alarm, or the surveillance message or the alarm is transferred to a centralized receiving point for alarms, c h a r a c t e r - i z e d in that said detector means include:

-at least one sensor (4) for monitoring physiological condition which includes at least one of the following conditions: temperature of the skin, electric conductivity of the skin and heartbeat;
-sensor (5) for detecting the hand movements; and
-fuzzy logic (7) for controlling the mutual dependency of the outputs from said sensors (4,5) such that the output from one of the sensors (e.g. 5) sets sliding alarm limits for the output from the other of said sensors (e.g. 4).

2. A device as set forth in claim 1, c h a r a c t e r i z e d in that the output from said movement activity sensor (5) determines said sliding alarm limits for the output from said physiological condition sensor (4).

3. A device as set forth in claim 1 or 2, c h a r a c t e r - i z e d in that the output from said physiological condition sensor (4) includes at least two signals, each representing one of said physiological conditions, whereby an alarm is triggered on if one of said two signals falls outside said sliding alarm limits.

4. A device as set forth in claim 1, c h a r a c t e r i z e d in that between the sensors (4,5) and said fuzzy logic (7) there is at least one counter (7A,7B) which switches on radio transmitter (9), which sends an alarm to a receiver (10) if said counter (7A; 7B) is not reset within a predetermined period of time.

5. A device as set forth in claim 1, c h a r a c t e r i z e d in that said detector and transmitter unit (1) further includes a counter (8) for counting a predetermined number of pulses delivered by said movement activity sensor (5) so as to switch on radio transmitter (9) and to send out a so-called dementia message indicating that a monitored person is moving.

6. A device as set forth in claim 1, c h a r a c t e r i z e d in that said physiological condition sensor (4) includes a measuring sensor (4) for electric conductivity of the skin and is also provided with a temperature measuring sensor.

7. A device as set forth in claim 1, c h a r a c t e r i z e d in that a high electric resistance of the skin decelerates a counter (7A) between the movement activity sensor (5) and the fuzzy logic (7) and a low electric resistance of the skin accelerates said counter (7A).

8. A device as set forth in any of the claims 1, 2, 3 or 4, c h a r a c t e r i z e d in that the movement activity sensor (5) is an acceleration sensor.

9. A device as set forth in claim 8, c h a r a c t e r i z e d in that in addition to the general movement activity, said acceleration sensor (5) indicates the rate of acceleration of individual hand movements.

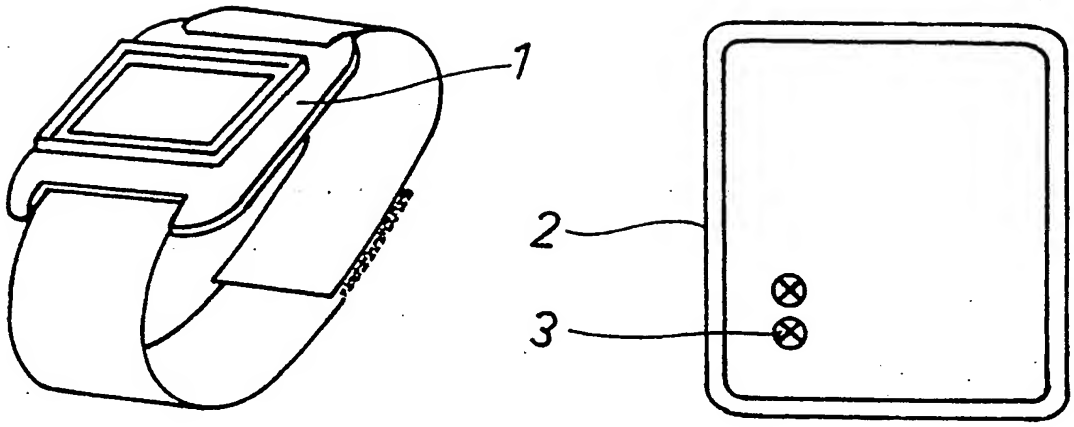

Fig. 1

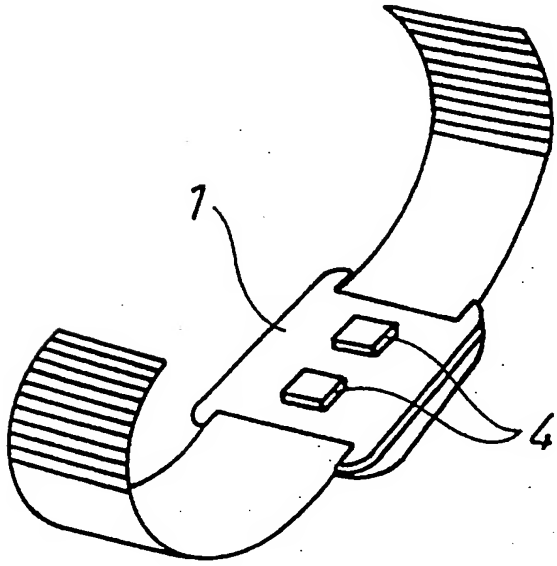

Fig. 2

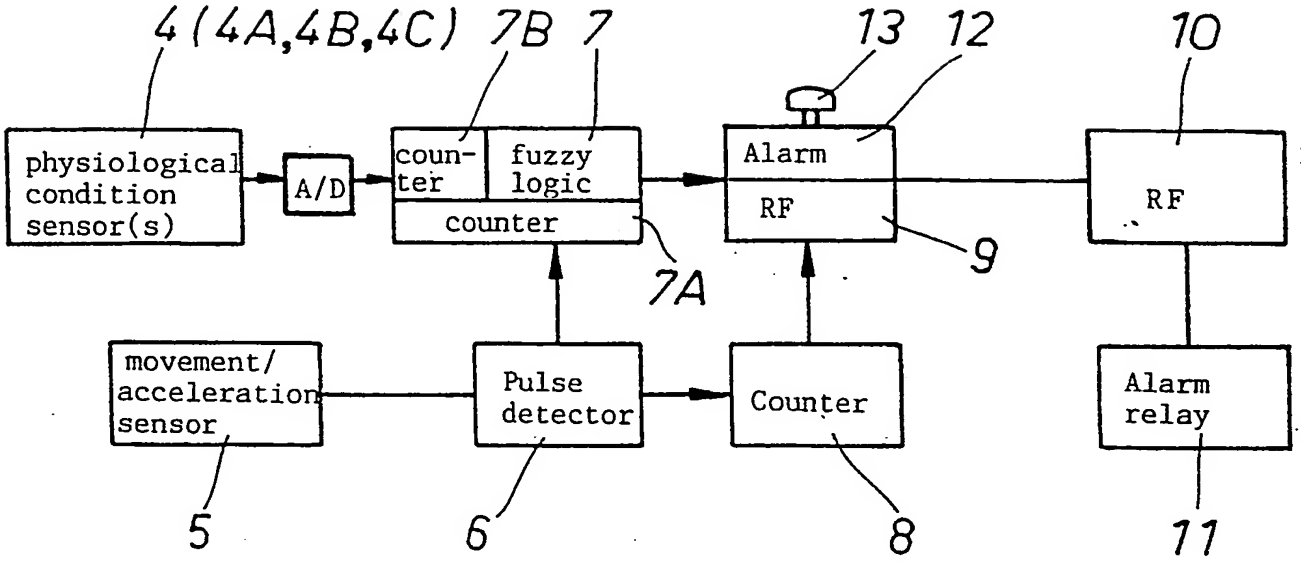
4 (4A,4B,4C)
7B
7
13
12
10
physiological condition sensor(s)
A/D
coun-ter
fuzzy logic
counter
Alarm
RF
RF
7A
9
movement/ acceleration sensor
Pulse detector
Counter
Alarm relay
5
6
8
11

Fig. 3

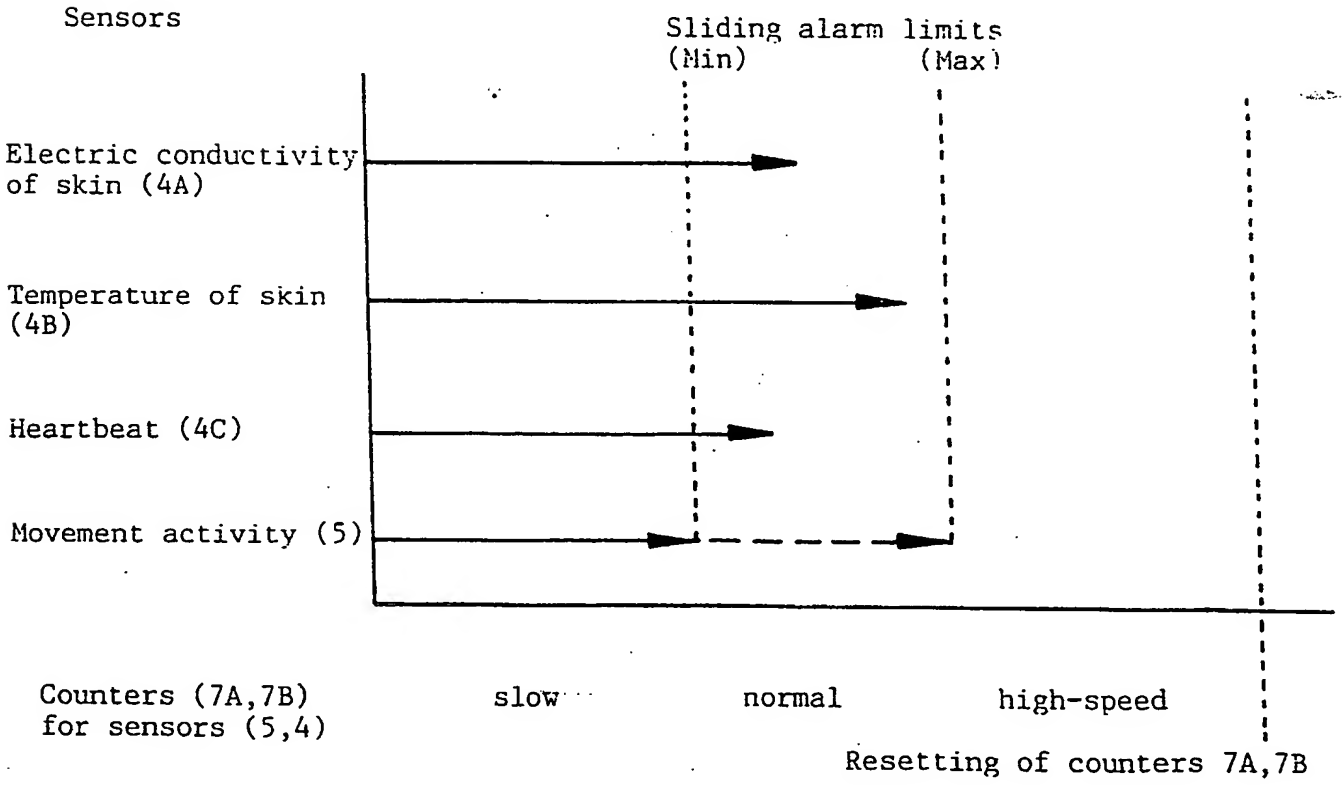
Sensors
Sliding alarm limits
(Min)
(Max)
Electric conductivity of skin (4A)
Temperature of skin (4B)
Heartbeat (4C)
Movement activity (5)
Counters (7A,7B) for sensors (5,4)
slow
normal
high-speed
Resetting of counters 7A,7B

Fig. 4

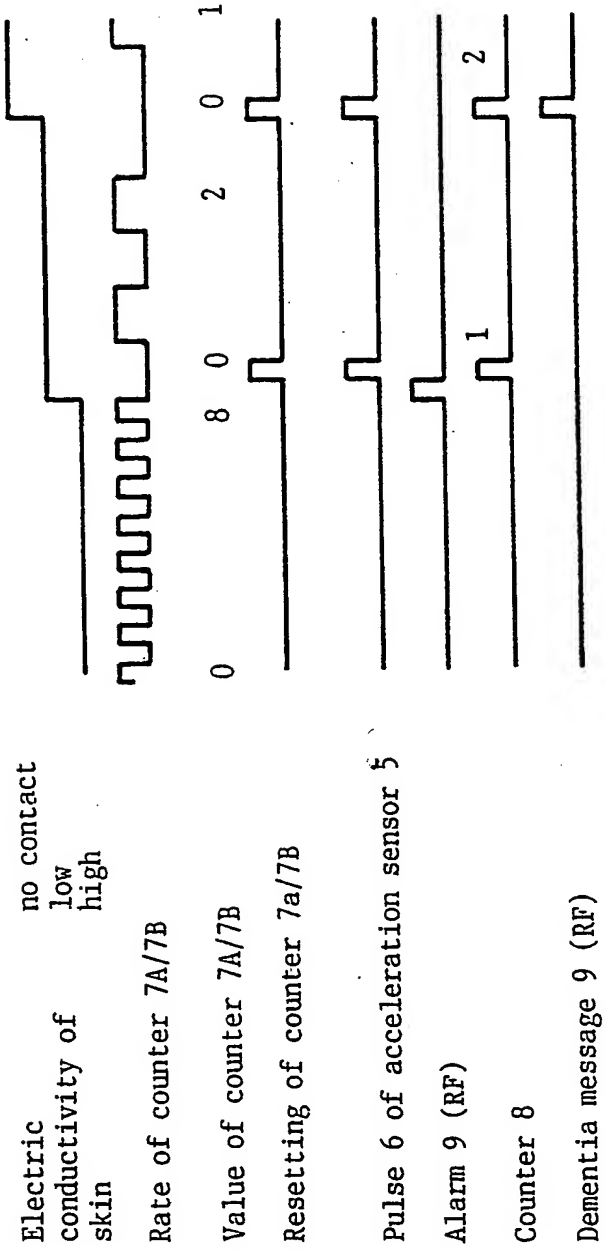
Electric conductivity of skin
no contact
low
high
Rate of counter 7A/7B
Value of counter 7A/7B
0
8
0
2
0
1
Resetting of counter 7a/7B
Pulse 6 of acceleration sensor 5
Alarm 9 (RF)
1
2
Counter 8
Dementia message 9 (RF)

Fig.5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 93/00067

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: A61B 5/11, A61B 5/0205, G08B 21/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: A61B, G08B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

ORBIT: WPI, CLAIMS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 4819860 (JAMES L. HARGROVE ET AL), 11 April 1989 (11.04.89), column 1, line 47 - column 2, line 3 --	1-9
A	US, A, 4952928 (GARY T CARROLL ET AL), 28 August 1990 (28.08.90), abstract --	1-9
A	US, A, 4958645 (THEODORE E. CADELL ET AL), 25 Sept 1990 (25.09.90) --	1-9
A	US, A, 4938228 (WILLIAM H. RIGHTER ET AL), 3 July 1990 (03.07.90), claims 1-8 --	1

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Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US, A, 5025791 (MINORU NIWA), 25 June 1991 (25.06.91), column 1, line 66 - column 2, line 13 --	1
A	US, A, 4052979 (MARY ANN SCHERR ET AL), 11 October 1977 (11.10.77), column 1, line 59 - column 2, line 47 --	1

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4819860	11/04/89	NONE	
US-A- 4952928	28/08/90	EP-A- 0357309	07/03/90
US-A- 4958645	25/09/90	NONE	
US-A- 4938228	03/07/90	AU-A- 5197990 EP-A- 0458896	05/09/90 04/12/91
US-A- 5025791	25/06/91	JP-A- 2258576	19/10/90
US-A- 4052979	11/10/77	NONE	